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amendments.*(54) Title: PROCESS FOR THE MODIFICATION OF A POLYESTER MELT USED IN A CONTINUOUS MELT-TO-PREFORM
PROCESS

(57) Abstract

A process for the modification of the properties of polyesters produced in a continuous melt-to-mold process, in which the polyester is prepared, modified, and formed into useful shaped articles in a single, integrated process. Modification is accomplished by the introduction of additives to the polymer melt stream at various points in the process. Modifiers employed may include colorants, stabilizers, antioxidants, catalyst deactivators, acetaldehyde scavengers, and the like. The modifiers may be introduced in such a way as to affect either the entire product stream, or optionally only a portion of it. This process allows the use of certain modifiers, such as catalyst deactivators, which are not practical to use in conventional processes.

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5 PROCESS FOR THE MODIFICATION OF A POLYESTER MELT USED IN A
CONTINUOUS MELT-TO-PREFORM PROCESS

BACKGROUND OF THE INVENTION

10 FIELD OF THE INVENTION

The present invention relates to a process for the incorporation of additives which modify the properties of polyesters produced in a continuous melt-to-mold process. The polyester is prepared, modified, and formed into useful shaped articles in a single, integrated process. Modifiers are added to a polymer melt stream at any of a variety of points in the manufacturing process. Modifiers include colorants, stabilizers, antioxidants, catalyst deactivators and acetaldehyde scavengers, among others.

DESCRIPTION OF THE PRIOR ART

It is known in the art that polyesters may be used for the manufacture of fibers, molded
20 objects, films, sheeting, food trays, as well as food and beverage containers. For certain of
these applications, particularly food and beverage containers, in which a high molecular

weight polyester that is essentially free of undesirable side products is needed, the polyester is conventionally prepared by a three-stage process involving melt-phase preparation of a precursor polyester of moderate molecular weight; pelletization, followed by crystallization and further polymerization in the solid state to a desired high molecular weight; and remelting and molding of the polyester to form the finished article.

It is often desirable to mix certain additives with the polymer before the final shaped object is produced. Such additives might include colorants, antioxidants, stabilizers, acetaldehyde scavengers, and the like. These additives, and others known in the art, may be used to provide superior properties to the shaped article being produced.

With conventional polyester processes there are few options for carrying out this addition. Since the polymer must be in the molten state in order to achieve good mixing of the additives, they may only be added during the initial polymerization stage, before the prepolymer is solidified; or during the final molding operation. Each option has its advantages and its drawbacks.

Any additive combined in the initial polymerization stage, whether it be at the beginning, the end, or at some intermediate stage, must be chemically stable with respect to the subsequent polymerization conditions, and must not interfere with the polymerization reaction itself. Moreover, any additive combined in this way affects the entire production

run of the polyester. This may make the process uneconomical in cases where it is desired to produce relatively small batches of specifically-treated polymer. The early addition of materials to the process assures their complete and uniform mixing throughout the polymer mass.

5

Alternatively, conventional processes may be operated in such a way that additives and modifiers are mixed into the polymer mass only at the final melting and shaping stage. With the use of this method, fewer demands are placed on the additives with regard to chemical stability or compatibility with the polymerization process. Additionally, it is convenient to prepare relatively small batches of customized products in this way. However, addition of materials at this stage is difficult to control, and great care must be taken to assure adequate mixing of the additives into the molten polymer before the shaped article is formed.

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The prior art describes a continuous melt phase process for the production of shaped articles such as bottle preforms, but it does not address modification of the melt stream by the addition of colorants, stabilizers, catalyst deactivators, anti-oxidants, etc. at various points in the process.

20

U.S. patent 5,308,892 describes a process for preparing a polyester master-batch containing finely divided additives. U.S. patents 5,376,702 and 5,485,478 describe a

process and apparatus for the modification of a polymer melt stream by adding materials to a side stream from the main melt stream, mixing in the additives, and recombining the side stream with the main stream. U.S. patent 5,564,827 describes a static mixing element useful for the homogenization of high-viscosity fluids. U.S. Patent 5,656,221 and German
5 patent DE 19505680 describe melt-to-parison processes, but also fail to address the incorporation of additives and modifiers at various points in the process.

It is apparent that each of the prior art methods of adding modifiers to the polyester has drawbacks. The present invention provides a process whereby shaped articles may be
10 prepared from modified polyesters such as PET or similar polymers, wherein the polymer is modified by the addition of one or more substances which impart desirable properties to the shaped article. The invention to provide a means of modifying polymers with additives which cannot be used in the conventional three-stage process due to their incompatibility with the polymerization reaction.

15

It has been unexpectedly found that it is now possible to combine various desirable additives with the polymer melt at virtually any stage in a continuous melt to mold the process. In particular, this allows the use of certain additives which impart desirable characteristics to the shaped articles, but were impossible or impractical to use in the conventional
20 processes.

SUMMARY OF THE INVENTION

The invention provides a process for the continuous production of molded polyester articles which comprises:

- a) reacting polyester homopolymer or copolymer precursors in a reactor under conditions
- 5 sufficient to produce a stream of molten polyester homopolymer or copolymer;
- b.) optionally filtering the stream of molten polyester;
- c.) optionally mixing the stream of molten polyester;
- d.) optionally devolatizing the stream of molten polyester;
- e) flowing the stream of molten polyester into at least one molding apparatus and forming
- 10 a solid molded article therefrom without solidifying the polyester prior to entry into the molding apparatus; and
- f) blending at least one polyester modifier with the polyester while it is in the molten state.

15

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a schematic view of the process sequence according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In the practice of the present invention, a polyester composition is prepared which may be

20 produced by condensing a dibasic acid, such as a dicarboxylic acid or a lower alkyl diester thereof with a glycol. Among the dicarboxylic acids and their lower alkyl diesters which

may be employed to form a flexible polyester film support are terephthalic; isophthalic; phthalic; naphthalene dicarboxylic; succinic; sebacic; adipic; azelaic; bibenzoic; the hexahydrophthalics, and bis-p-carboxy-phenoxyethane. Highly useful naphthalene dicarboxylic acids include the 2,6-, 1,4-, 1,5-, or 2,7- isomers but the 1,2-, 1,3-, 1,6-, 1,7-, 1,8-, 2,3-, 2,4-, 2,5-, and/or 2,8- isomers may also be used. Dibasic acids may contain from about 2 to about 40 carbon atoms and include isophthalic, adipic, glutaric, azelaic, sebacic, fumaric, dimer, cis- or trans-1,4-cyclohexanedicarboxylic, the various isomers of naphthalenedicarboxylic acids and the like. Preferred dibasic acids include terephthalic acid, isophthalic acid, naphthalene dicarboxylic acid, cyclohexane dicarboxylic acid and mixtures thereof. The dibasic acids may be used in acid form, acid anhydride form or as their esters such as the dimethyl esters. One or more of these acids and/or their lower alkyl diesters is reacted with one or more glycols which include glycols having from about 3 to about 10 carbon atoms and include ethylene glycol, propylene glycol, 1,3-propanediol, 1,4-butanediol, 1,6-hexanediol, diethylene glycol, 1,4-cyclohexanediol, 1,4-cyclohexanedimethanol, neopentyl glycol and the like. The 1,4-cyclohexanedimethanol may be in the cis or the trans form or as cis/trans mixtures. Preferred glycols include ethylene glycol, 1,4-cyclohexane dimethanol diethylene glycol and mixtures thereof. Since one or more diesters may be reacted with one or more glycols, the polyester film of this invention is not limited to homopolyesters but also includes mixed polyesters such as copolyesters as well as copolymers with other monomers.

Polymers that are particularly useful in this process include poly(ethylene terephthalate), poly(ethylene naphthalenedicarboxylate), and copolyesters containing up to about 50 mol% of modifying dibasic acids and/or glycols. Of the polyesters within the contemplation of this invention, preferred are those containing at least a major amount of polyethylene terephthalate, the most preferred are those containing at least 80 mol% terephthalic acid and 80 mol% ethylene glycol on a 200 mol% basis. Polyethylene terephthalate is formed from a polymer produced by the polymerization of bis-(2-hydroxyethyl) terephthalate which is itself formed as an intermediate by one of two different methods. One method for producing bis-(2-hydroxyethyl) terephthalate is by direct esterification of terephthalic acid with ethylene glycol as described in U.S. Pat. No. 3,050,533. In this method the by-product of the reaction is water which is distilled from the reaction product. A second method for producing bis-(2-hydroxyethyl) terephthalate is by transesterification of dialkyl ester of terephthalic acid, preferably dimethyl terephthalate, with ethylene glycol. Preferably, two molecular proportions of ethylene glycol react with one molecular proportion of the dialkyl terephthalate. More preferably, more than two molecular proportions of ethylene glycol per molecular proportion of the dialkyl terephthalate are used since under these conditions the initial transesterification reaction occurs more rapidly and completely. The transesterification reaction is conducted under conditions of elevated temperature. For example, a temperature in the range of from about the boiling temperature of the reaction mixture to as high as 250° C. may be used. The reaction can occur at atmospheric, sub-atmospheric or super-atmospheric pressure. A

by-product of the transesterification reaction is an alkanol. For example, if dimethyl terephthalate is used, methanol is produced. The alkanol is then removed from the reaction product.

- 5 In order to increase the reaction rate, many known catalysts may be employed in the transesterification reaction. Typical polyesterification catalysts which may be used include titanium alkoxides, dibutyl tin dilaurate, and antimony oxide or antimony triacetate, used separately or in combination, optionally with zinc, manganese, or magnesium acetates or benzoates and/or other such catalyst materials as are well known to those skilled in the art.
- 10 Phosphorus and cobalt compounds may also optionally be present from the beginning of the reaction, or may be added at any convenient point in the process.

After the intermediate bis-(2-hydroxyethyl) terephthalate has been produced, it may be converted to polyethylene terephthalate by heating at a temperature above the boiling

15 point of the ethylene glycol or the reaction mixture under conditions effecting the removal of the glycol or water. The heating may occur at a temperature as high as 325° C., if desired. During heating, pressure is reduced so as to provide rapid distillation of the excess glycol or water. The final polyethylene terephthalate polymer may have an intrinsic viscosity, as measured in orthochlorophenol at 25° C., in excess of 0.3 deciliter per gram.

20 More preferably, the intrinsic viscosity of the polymer ranges from about 0.4 to about 1.0 deciliter per gram, measured in orthochlorophenol at 25° C. Still more preferably, the

polyethylene terephthalate employed in the present invention has an intrinsic viscosity of about 0.5 to about 0.7 deciliter per gram as measured in orthochlorophenol at 25° C. The thermoplastic polyester containing polymers of this invention have a preferred melting point in the range of from about 200 °C to about 330 °C or more preferably from about
5 220 °C to about 290 °C and most preferably from about 250° C. to about 275° C.

Suitable for use as comonomers in polyester copolymers are such components as ethers, esters and partial esters of acrylic and methacrylic acid and of aromatic and aliphatic polyols. The production of such copolymers is well known in the art.

10

A key feature of the present invention is the addition of additives which modify the properties of polyesters produced in a continuous melt-to-mold process. That is, after the polyester is prepared as indicated above, it is modified by the inclusion of known polyester additives and formed into useful shaped, molded articles in a single, integrated process
15 without an intermediate solidification of the polyester.

Many different kinds of additives can be employed, depending on the nature of the desired properties in the finished article. Such additives may include, but are not limited to, art recognized colorants, anti-oxidants, acetaldehyde reducing agents, stabilizers, e.g. uv and
20 heat stabilizers, impact modifiers, polymerization catalyst deactivators, melt-strength

enhancers, antistatic agents, lubricants, chain extenders, nucleating agents, solvents, fillers, plasticizers and the like.

Suitable colorants include dyes and pigments. Useful colorants non-exclusively include
5 dyes such as Victoria Pure Blue BO (Basic Blue 7, CI 42595) available as BASF Flexo
Blue 636 from BASF Corp. of Parsippany, New Jersey, Rhodamine, Chalcozine, Victoria
Blue and methyl violet and pigments such as the anthraquinone and phthalocyanine types.
Perylene maroon, phthalocyanine blue, phthalocyanine green and cadmium red are
similarly useful.

10

Acetaldehyde reducing agents include polyamides such as those disclosed in U.S. Patent
Nos. U.S. 5,266,413; 5,258,233 and 4,8837,115; polyesteramides; nylon-6 and other
aliphatic polyamides such as those disclosed in Japan Patent Application Sho 62182065
(1987); ethylenediaminetetraacetic acid as disclosed in U.S. patent 4,357,461, alkoxylated
15 polyols as disclosed in U.S. patent 5,250,333, bis(4- β -hydroxyethoxyphenyl)sulfone as
disclosed in U.S. patent 4,330,661, zeolite compounds as disclosed in U.S. patent
5,104,965; 5-hydroxyisophthalic acid as disclosed in U.S. patent 4,093,593; poly(ethylene
isophthalate) as disclosed in U.S. patent 4,403,090, supercritical carbon dioxide as
disclosed in U.S. patents 5,049,647 and 4,764,323) and protonic acid catalysts as
20 disclosed in U.S. patents 4,447,595 and 4,424,337.

A suitable impact modifier is ethylene methyl acrylate. Antistatic agents include stearamidopropyldimethyl- β -hydroxyethylammonium nitrate as disclosed in U.S. patent 4,302,505.

- 5 Solvents for the melt include alcohols such as methanol, ethanol, propanol, butanol, benzyl alcohol and phenoxyethanol; ketones such as acetone, methyl ethyl ketone, methyl isobutyl ketone, cyclohexanone, diisobutyl ketone, etc., esters such as ethyl acetate, butyl acetate, amyl acetate, methyl formate, ethyl propionate, dimethyl phthalate, ethyl benzoate, methyl Cellosolve acetate, ethylene glycol monoethyl ether acetate and ethyl
- 10 lactate; aromatic hydrocarbons such as toluene, xylene, benzene, ethylbenzene; halogenated hydrocarbons such as carbon tetrachloride, trichloroethylene, chloroform, 1,1,1-trichloroethane, 1,2-dichloroethane, monochlorobenzene, chloronaphthalene; ethers such as tetrahydrofuran, diethyl ethers, ethylene glycol monoethyl ether, ethylene glycol monomethyl ether, propylene glycol monomethyl ether, etc., dimethylformamide, dimethyl
- 15 sulfoxide, N-vinyl pyrrolidone, etc., and mixtures thereof.

A particularly advantageous embodiment is the addition of a polymerization catalyst deactivator, preferably at the point that the polymer stream exits the polymerization reactor. Such deactivators may include compounds such as phosphate esters, tri-sodium

20 phosphate, tri-potassium phosphate, alkyl or aromatic amines, amides, alkoxides, etc. In this embodiment, full catalytic activity is retained during the polymerization, thus

minimizing the time needed for polymerization. Immediately after the desired molecular weight is reached, the polymerization catalyst is essentially deactivated. By this technique, further side reactions are drastically reduced throughout the rest of the process, and articles having exceptionally good color and thermal stability are produced.

5

A particularly useful embodiment of the process uses gallium, in the form of gallium salts such as gallium lactate, as the polycondensation catalyst, followed by deactivation of the gallium by addition of a phosphate compound such as phosphoric acid, triphenyl phosphate, or the like immediately after the polymerization process is completed. In this
10 embodiment, a particularly inert and stable polyester melt is produced, which suffers far less degradation and color formation during subsequent processing. Another particularly useful embodiment of this invention, when colorants are used, is to add the colorants to the melt streams feeding individual molding machines. Optionally, a mixing section can be placed in the melt stream immediately following the addition point and prior to a molding
15 machine. In this way, different colors can be used for different molding machines as desired, colors can be rapidly changed, and the relative amount of each product produced can be varied as needed. This makes the production of small batches of specialized products more economical.

20 Antioxidants include such compounds as phenols and particularly hindered phenols including Irganox 1010 from Ciba-Geigy; sulfides; organoboron compounds;

organophosphorous compounds; N, N'-hexamethylenebis(3,5-di-*tert*-butyl-4-hydroxyhydrocinnamamide) available from Ciba-Geigy under the tradename "Irganox 1098". Stabilizers include hindered amines benzotriazole, hydroxybenzophenone, and the like. A suitable stabilizer is diglycidyl ether bisphenol A having a molecular weight of

5 2,000.

Fillers may be selected from a wide variety of minerals, metals, metal oxides, siliceous materials, metal salts, and mixtures thereof. Examples of fillers included in these categories are titanium dioxide, alumina, aluminum hydrates, feldspar, asbestos, talc, calcium

10 carbonates, clay, carbon black, quartz, novaculite and other forms of silica, kaolinite, bentonite, garnet, mica, saponite, beidelite, calcium oxide, calcium hydroxide, etc.

Examples of suitable plasticizers include dioctyl phthalate, dibutyl phthalate, butyl phthalyl, butyl glycolate, tricresyl, phosphate, polyester series plasticizers and chlorinated

15 paraffins.

Nucleating agents include alkali metal salts of carboxylic acids which may be prepared by reacting an organic carboxylic acid with a Group I metal base to form a Group I metal salt. Suitable carboxylic acid containing compounds include such aromatic acids as

20 benzoic acid and substituted benzoic acid, aliphatic acids such as pivalic acid, fatty acids such as stearic acid, palmitic acid, and dimer acids. A preferred nucleating agent is sodium

stearate. Other nucleating agent include metal salt ionomers such as an alkali metal salt ionomer. Ionomers useful for this invention include those disclosed in U.S. patents 4,381,376; 4,603,172 and 4,412,040.

- 5 The polyester modifiers listed above are typically blended with the polyester in an amount of from about 0.01 to about 15 weight percent based on the total weight of the modified polyester.

After reacting the polyester homopolymer or copolymer precursors in a reactor, molten
10 polyester homopolymer or copolymer may be optionally filtered, mixed or otherwise agitated, devolatilized and then flowed into at least one molding apparatus thus forming a solid molded article therefrom without solidifying the polyester prior to entry into the molding apparatus.

- 15 A filter is preferably used to homogenize the melt and remove impurities. Melt filters and mixers are well known in the art as exemplified by U.S. patent 5,564,827. Devolatilizing is done to remove gases and other volatile components in the melt. Such are typically done in a devolatilizing twin or multiscrew extruder with vacuum degassing as is well known in the art. Devolatilizing is exemplified by U.S. patents 5,376,702; 5,458,478 and 5,308,892.

For the purposes of this invention, molding includes any known manner of producing shaped solid articles from a melt. The compositions of the invention are useful for manufacturing shaped articles, such as structural parts by such processes as injection molding, gas-assist injection molding, blow molding, extrusion thermoforming and the like. Molding may be done in a commercially available molding machine such as 150 ton Cincinnati molder. The possible points of addition of the modifiers include in the melt phase reactor; immediately after the polymerization is finished; immediately before a mixing element located in the melt distribution line; immediately before a distribution valve, and to lines feeding individual molding machines. It will be appreciated that other addition points are also possible, and that more than one addition point may be used in any given process.

Figure 1 shows a schematic view of the process sequence according to the invention. Melt is produced in polymerization reactor 2 and flows through optional filter 4, optional mixer 6 and optional devolatilizers 8 to suitable molding machines 8 in a continuous process without intermediate solidification or remelting of the polyester. It is understood that the polymerization reactor 2 can also comprises two or more reaction steps involving melt-phase preparation of a precursor polyester of moderate molecular weight followed by crystallization and further polymerization in the solid state to a desired high molecular weight. In such a case the addition can occur at either the preparation of a precursor polyester stage or crystallization and further polymerization stage or both, or between these two stages. At least one modifier is added at one or more points along the sequence of

steps. Such may be conducted in the polymerization reactor 2; after the polymerization reactor 2 but before filter 4; during filtering in filter 4; after filtering in filter 4 but before mixing in mixer 6; during mixing in mixer 6; after mixing in mixer 6 but before entering devolatilizers 8; during devolatilizing in devolatilizers 8; or after devolatilizing in

5 devolatilizers 8 but before molding in molders 10. It is within the contemplation of the invention that different additives may be added at different points as desired by the user. For example, different colorants may be added to different devolatilizers 8 to produce different colored moldings in molders 10. It will also be appreciated that a plurality of polymerization reactors, filters, mixers and devolatilizers may feed one or more molding
10 machines either in series or parallel.

The following non-limiting examples serve to illustrate the invention. However it will be understood that they are provided merely for illustrative purposes, and are not intended to limit the scope of the invention in any way.

15

COMPARATIVE EXAMPLE A

Filtered polyethylene terephthalate (PET) modified with 3.5 mol % 1,4-cyclohexanedimethanol (a 30/70 mol% cis,trans- mixture) and with an IhV = 0.64 is fed to vented twin-screw reactor. After a residence time of 25 min at a temperature of 275 ° C
20 and a pressure of 0.75 torr, the polymer has an IhV = 0.75 and residual acetaldehyde of 5 ppm. As used herein, the term "IhV" refers to inherent viscosity of the polymer as

determined by a solution of 0.5 gram of polymer dissolved in 100 ml of a mixture of phenol (60% by volume) and tetrachloroethane (40% by volume). The polymer is then pumped to molding machines through a system of distribution pipes and valves at a mean residence time of approximately 7 minutes. The molding machines each have a residence
5 time before the polymer has been cooled below 200 °C of approximately 40 seconds. The amount of residual acetaldehyde in the molded 0.75 IhV preforms is 15 ppm.

EXAMPLE 1

The process of Comparative Example A is used, but an injection port is added to the
10 process stream immediately following the final twin-screw reactor. A static mixing element is placed in the line following the addition port. A gear pump is used to meter phosphoric acid through the addition port at a rate such that 210 parts by weight of phosphorus per million parts by weight polyester is added to the stream. The final molded preforms have IhV 0.73 dl/g and residual acetaldehyde 6 ppm.

15

EXAMPLE 2

PET is prepared to an IhV = 0.74 with a final melt temperature of 285 °C, filtered, and then the flow is split and distributed to ten devolatilizing vented extruders. Each stream has a flow rate equal to the capacity of one multi-cavity molding machine. To three of the
20 streams is added a side stream of green colorant dispersed in molten PET, and to two other streams is added an amber colorant, similarly dispersed in PET. The polymer

entering the devolatilizing extruders contains 210 ppm residual acetaldehyde. The devolatilizers are purged with nitrogen. While in the devolatilizer for a mean residence time of 15 min, the polymer is cooled to 280 °C. The polymer exiting the devolatilizer has 7 ppm residual acetaldehyde, and is ejected directly to a multi-cavity molding machine.

- 5 The residence time in the molding machine is approximately 50 seconds. The preforms produced have an $IhV = 0.77$ and acetaldehyde = 8 ppm. Of the total production of preforms, 30% are green, 20% are amber, and 50% are clear.

EXAMPLE 3

- 10 This example uses the same equipment configuration as Example 2. PET is prepared to an $IhV = 0.75$ at 270 °C in the melt-phase reactors. The output of the reactors is divided into ten streams, feeding ten devolatilizing stations and ten molding machines and contains 80 ppm residual acetaldehyde after filtration and transport to the devolatilizing extruders. At the end of the devolatilizer is added 0.5 wt % of a polyamide prepared from adipic acid
- 15 and m-xylylenediamine, by means of a gear pump, and the polymer is ejected through a static mixing section directly to a multi-cavity molding machine. After 5 min residence time in each devolatilizer under nitrogen purge, and approximately 2 min traveling to the molds before being cooled, the polymer has an $IhV = 0.75$ and a residual acetaldehyde content of 4 ppm. There is no significant difference in acetaldehyde content among green,
- 20 amber, or clear preforms.

What is claimed is:

1. A process for the continuous production of molded polyester articles which comprises:

a) reacting polyester homopolymer or copolymer precursors in a reactor under conditions sufficient to produce a stream of molten polyester homopolymer or copolymer;

5 b.) optionally filtering the stream of molten polyester;

c.) optionally mixing the stream of molten polyester;

d.) optionally devolatilizing the stream of molten polyester;

e) flowing the stream of molten polyester into at least one molding apparatus and forming a solid molded article therefrom without solidifying the polyester prior to entry into the

10 molding apparatus; and

f) blending at least one polyester modifier with the polyester while it is in the molten state.

2. The process according to claim 1 comprising the step of filtering the stream of molten polyester homopolymer or copolymer prior to flowing the stream of molten polyester into

15 the molding apparatus.

3. The process according to claim 1 comprising the step of mixing the stream of molten polyester homopolymer or copolymer prior to flowing the stream of molten polyester into the molding apparatus.

20

4. The process according to claim 1 comprising the step of devolatilizing the stream of molten polyester homopolymer or copolymer prior to flowing the stream of molten polyester into the molding apparatus.
- 5 5. The process according to claim 1 comprising the steps of filtering, mixing and devolatilizing the stream of molten polyester homopolymer or copolymer prior to flowing the stream of molten polyester into the molding apparatus.
6. The process according to claim 1 wherein the blending of at least one polyester modifier
10 with the polyester is conducted during step (a).
7. The process according to claim 1 wherein the blending of at least one polyester modifier with the polyester is conducted after step (a) but before step (b).
- 15 8. The process according to claim 1 wherein the blending of at least one polyester modifier with the polyester is conducted during step (b).
9. The process according to claim 1 wherein the blending of at least one polyester modifier with the polyester is conducted after step (b) but before step (c).

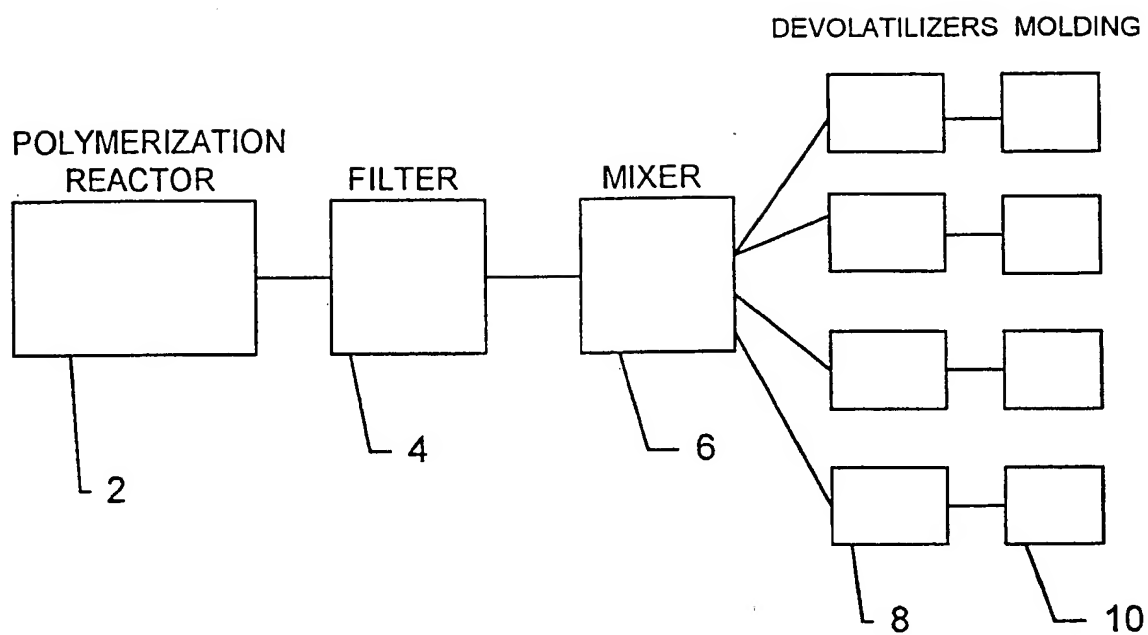


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